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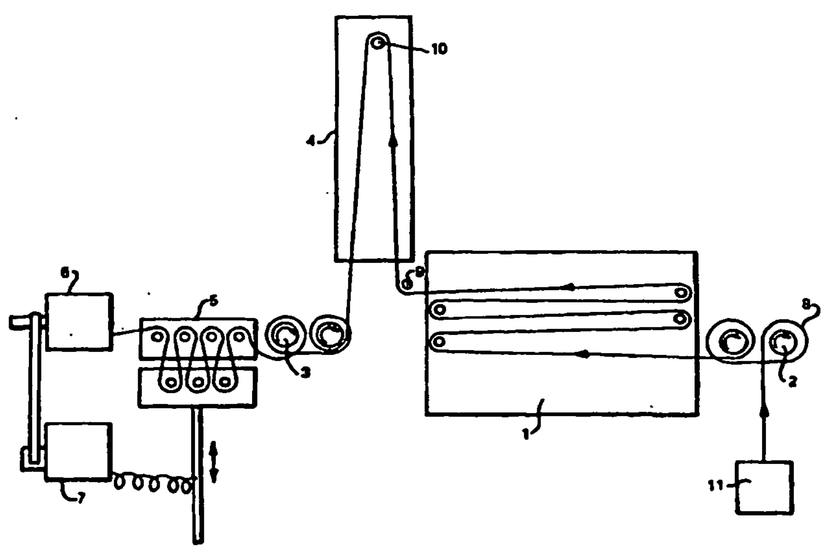

(57) Abstract

The present invention relates to improved woven sailcloths having the strength and stretch properties of laminated cloths and which are suitable for use on large boats. The invention provides a process for the manufacture of a normal tenacity yarn suitable for use in a woven sailcloth which also comprises a high modulus yarn, in which the normal tenacity yarn is pre-shrunk at a temperature greater than the heat-setting temperature of the normal tenacity yarn. The invention also provides a process for producing a woven sailcloth comprising a pre-shrunk normal tenacity yarn and a yarn setting machine for heat treatment of a synthetic yarn.

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IMPROVEMENTS IN SAILCLOTH

The present invention relates to sailcloth and in particular to an improved woven sailcloth having the strength and stretch properties of a laminated cloth, which is suitable for use on large classically designed boats.

In recent years there has been a large development in laminated sailcloth. This has been necessary as it is difficult to weave the modern high modulus yarns to produce a fabric with good dimensional stability in the zero, ninety degree and forty five degree directions. The laminating of the various components allows the high modulus yarns to be used to good effect but the process results in a fabric that is stiff, thick in relation to the unit weight and prone to de-laminate during use.

Laminated cloths consist of at least two components, but generally are made of three components. In one type of laminated cloth each of a loose woven polyester backing cloth and a tightly woven polyester front cloth are pre-coated with alternate parts of a two part adhesive. High tenacity warp yarns are placed between the two cloths at regular intervals and the sandwich so produced is passed through a rotary press to activate the adhesive. In another type of laminate a sheet of plastic film is placed between two high tenacity woven fabric cloths which have been pre-coated with alternate parts of a two part adhesive. Again the sandwich is passed through a rotary press to activate the adhesive.

The method of producing laminates makes the product more suitable for the manufacture of one particular sail design type and this is not always acceptable to the end user. There is a demand for a traditional woven cloth exhibiting the stretch and strength characteristics of a laminated cloth. The difficulty arises in conbining different fibres with different stretch and shrinking characteristics.

The high modulus fibres of the aramid, polyethylene and polyester-polyarylate types have a different rate of shrink under heat than normal tenacity yarns such as polyester, nylon or polypropylene. These high modulus yarns are sold under trade names such as KEVLAR, TWARON, TECHNORNA, DYNEEMA, SPECTRA and VECTRAN.

In the production of woven sailcloth the warp and weft fibres are combined in a cloth construction that will allow the tightest possible weave. The finishing process applies heat to the fabric and uses the shrinkage potential of the yarns to further tighten the weave. The forty five degree movement is partly controlled by the tight weave and this control is then reinforced by the application of resin. The resins are all commercially available. However, the difference in shrinkage between the high modulus yarns and the normal tenacity yarns make them unsuitable to weave in combination. For example VECTRAN has a less than 0.5% shrinkage potential whereas polyester has a shrinkage potential of about 2 to 19%. Thus when they are heat set together bubbles are formed in the VECTRAN fibres. This does not look good in the final appearance of the cloth. Furthermore, in use the bubbles must be pulled out when the cloth is being stretched under the force of the wind, before the VECTRAN comes into play in the strength of the sail.

In the very large 100 foot plus boats there are tremendous loads on the sails. These boats are very expensive costing between £2 and £6 million and the owners traditionally do not want to use laminated fabrics because they are expensive, they delaminate with use and age and they have asthetic problems in that they look out of place on an expensive, classic boat. The alternative is to use three thicknesses of polyester in the sailcloth but this produces a sail which is too heavy to manage easily in a boat of the size in question.

Thus the problems with the prior art sailcloths are that traditional woven cloths are not strong enough, woven cloths using high modulus yarns are not stable, laminated cloths are too heavy and de-laminate on use and woven cloths using high modulus yarns and normal tenacity yarns tend to have a bubbled appearance which affects both the performance and visual appeal of the cloth.

Accordingly, it is an object of the invention to produce a sailcloth which combines strength with stretch in an asthetically pleasing cloth. Ideally, one would like to produce a sailcloth which could stretch a little but known amount up to zero stretch and then recover but until the present time this has not been done. It is a further object of the invention to provide a sailcloth which is cheaper to produce than a laminated cloth, which has the same strength and stretch characteristics as a laminate and which is not significantly heavier than a laminate. It is a further object of the invention to provide a normal tenacity yarn which can be successfully woven with a high modulus yarn to produce a sailcloth.

According to the present invention there is provided a process for the manufacture of a normal tenacity yarn suitable for use in a woven sailcloth also comprising a high modulus yarn, wherein the normal tenacity yarn is pre-shrunk at a temperature greater than the heat-setting temperature of the normal tenacity yarn. Preferably, the yarn is pre-shrunk under a tension sufficient to stretch the yarn about 1.5%.

Suitably, polyester yarn is heated to at least 200^{o}C at a tension of at least 375 gms. Nylon is also suitably heated to at least 200^{o}C at a tension of at least 375 gms. Another suitable yarn for use in the process is polypropylene.

The invention also provides a pre-shrunk normal tenacity yarn which has been pre-shrunk at a temperature greater than the heat-setting temperature of the yarn and which has preferably been stretched about 1.5%.

The invention further provides a process for the manufacture of woven sailcloth comprising weaving a high modulus yarn with a normal

tenacity yarn wherein the normal tenacity yarn has been pre-shrunk at a temperature greater than the heat-setting temperature of the normal tenacity yarn. The yarn is also preferably stretched about 1.5%.

Preferably, the high modulus yarn is woven in the weft direction and the normal tenacity yarn is woven in the warp direction. In a sailcloth intended for use with a modern boat the high modulus yarn is used in the warp direction and the normal tenacity yarn used in the weft direction, whereas in a sailcloth intended for use on a classic boat the high modulus yarn is used in the weft direction.

By pre-shrinking the normal tenacity yarn to a value similar to that of the high modulus yarn the invention has made it possible to combine the two components in a single fabric which does not contain bubbles in the final cloth.

The invention further provides a yarn setting machine for heat treatment of synthetic yarn comprising an oven, at least one roller over which the yarn is rolled through the oven and a winding head to draw the yarn through the oven and wind it onto a spool or the like. The machine may further comprise a cooling unit to cool the yarn emerging from the oven. The cooling unit preferably has at least one roller to roll the yarn through the unit. Preferably the machine is also provided with a means to adjust the tension of the yarn passing through the setting machine. This means may be a tension compensator which controls the speed of the drive of the winding head.

The invention will now be described in greater detail with reference to the following Examples and to the accompanying drawing, Figure 1 which is a schematic drawing of a yarn setting machine.

As shown in the accompanying drawing a yarn setting machine for heat treatment of synthetic yarn consists of an oven (1), which can be heated using electricity in the range of ambient to 350^{o}C under the control of a thermostat. Alternatively gas heating or hot air may be used. Rollers (2) and (3) are used to roll the yarn through the oven (1). These are driven by means of chain and sprockets or alternatively toothed belts and wheels, hydraulic motors, or individual electric motors may be used. A means to allow the speed of rollers (2) to be

different to the speed of rollers (3) is provided, such as change gear wheels or variable speed drive. The difference in speed between rollers (3) and (2) determines the tension in the yarn during the treatment. A tension meter is used adjacent to rollers (3) from time to time to measure the tension. A cooling unit (4) is provided to cool the yarn emerging from the oven (1), the cooling being assisted by a fan and/or cooled air. The yarn is wound using a commercially available winding head (6). A tension compensator (5) is provided which moves to take up any slack and which has an output either mechanically or electronically to control the speed of the drive (7) of the winding head (6) to allow for the slack. All parts of the machine which are in contact with the yarn are smooth and should preferably be made from or coated with a ceramic material.

In use the yarn (8) as supplied by a manufacturer is taken from the supply package (11) and passed around the rollers (2), the number of turns dependant on the thickness and type of yarn to be processed. The yarn (8) then passes through the oven (1), the yarn (8) being passed backwards and forwards in the oven (1) using a plurality of guides, to increase the total length of yarn in the oven depending on the thickness and type of yarn (8) to be processed. The yarn (8) exits onto guide (9), enters the cooling unit (4) and is returned by guide (10) onto rollers (3). The yarn (8) is passed around the guides within the compensator (5), the number of guides used depending on the thickness and type of yarn processed. The yarn (8) is then wound on the winding head (6).

The yarn must be processed at a higher temperature than the cloth will subsequently be subjected to in manufacture. The setting temperature is therefore dependant on the curing temperature of the resin system in the sailcloth manufacture and adjusted for any modifiers that may be added to the mixture. The heat setting temperature of the normal tenacity yarn must be exceeded.

When pre-shrinking the yarn it has been found that the final result is influenced by yarn speed, temperature, cooling time and cooling temperature, process tension, process length and speed. All of these factors influence the temperature and tension which the yarn achieves. Varying the above conditions allows different results to be produced in the yarns.

EXAMPLES

The following are process parameters which produce a polyester yarn which can be successfully woven with a high modulus yarn to produce a sailcloth, the tension being measured on a Schmidt Model ZD Tension meter in accordance with procedures well known in the art.

Example	Yarn Weight (dtex)	Oven ^{o}C	Speed m/s	Oven length m	Cooling length m	Tension
(1)	1100	250	0.9	2	2	750 gms
(2)	1100	220	0.7	2	2	750 gms
(3)	1100	250	2.5	6	4	750 gms
(4)	550	250	1.5	2	2	375 gms
(5)	550	220	0.9	2	2	375 gms
(6)	550	200	2.5	6	2	375 gms
(7)	830	250	1.5	2	2	565 gms

The tenacity value of a yarn is an indication of the strength of the yarn and is calculated as:-

Load at break in cN/Tex of yarn.

Modulus is an indication of the resistance to stretch and is calculated as:-

(Load at break in cN/Tex) x(100/% extension).

This gives a modulus value at break but for the purposes of yarn and cloth manufacture one is interested in how yarns resist stretch at lower loads rather than break. The latter calculation can be adapted to give values at different points prior to the yarn breaking:-

(Load in cN at % extension/Tex) x (100/% extension).

In general terms yarns can be divided into four categories. Low

tenacity yarns include natural fibres and some man-made fibres for apparel uses, medium tenacity yarns include man-made fibres for general purpose non-critical end use and high tenacity yarns include man-made fibres for industrial uses such as sails, tyres and the like. High modulus yarns are high strength yarns with the advantage of high resistance to stretch and include yarns such as Kevlar, Spectra and Vectran (all trade marks). The dividing line between the first three categories is not well defined, but for the purpose of the present application low tenacity yarns would have a tenacity value of less than 45 cN/Tex. High tenacity yarns would have a tenacity value of between 45 and 95 cN/Tex with a 2% modulus figure (i.e. modulus calculated using the load at 2% extension) of between 550 and 950 cN/Tex. Yarns with values exceeding this would be considered to be high modulus yarns.

Claims

1. A process for the manufacture of a normal tenacity yarn suitable for use in a woven sailcloth also comprising a high modulus yarn, wherein the normal tenacity yarn is pre-shrunk at a temperature greater than the heat-setting temperature of the normal tenacity yarn.

2. A process as claimed in Claim 1 in which the yarn is pre-shrunk under a tension sufficient to stretch the yarn about 1.5%.

3. A process as claimed in Claim 1 or 2, in which the normal tenacity yarn is selected from polyester yarn, nylon or polypropylene.

4. A process as claimed in any preceding claim in which the normal tenacity yarn is heated to at least 200°C at a tension of at least 375 gms.

5. A pre-shrunk normal tenacity yarn whenever produced by a process as claimed in any preceding claim.

6. A pre-shrunk normal tenacity yarn which has been pre-shrunk at a temperature greater than the heat-setting temperature of the yarn.

7. A pre-shrunk normal tenacity yarn as claimed in Claim 6 which has been stretched about 1.5%.

8. A process for the manufacture of woven sailcloth comprising weaving a high modulus yarn with a normal tenacity yarn wherein the normal tenacity yarn has been pre-shrunk at a temperature greater than the heat-setting temperature of the normal tenacity yarn.

9. A process as claimed in Claim 8 wherein the normal tenacity yarn has been stretched about 1.5%.

10. A process as claimed in Claim 8 or 9 wherein the high modulus yarn is woven in the weft direction and the normal tenacity yarn is woven in the warp direction.

11. A process as claimed in Claim 8 or 9 wherein the high modulus yarn is woven in the warp direction and the normal tenacity yarn is woven in the weft direction.

12. A sailcloth whenever produced by a process as claimed in any of Claims 8 to 11.

13. A yarn setting machine for treatment of synthetic yarns comprising an oven, at least one roller over which the yarn is rolled through the oven and a winding head to draw the yarn through the oven and winded on to a spool.

14. A yarn setting machine as claimed in Claim 13 further comprising a cooling unit to cool the yarn emerging from the oven.

15. A yarn setting machine as claimed in Claim 14 wherein the cooling unit has at least one roller to roll the yarn through the unit.

16. A yarn setting machine as claimed in any of claims 13 to 15 also comprising a means to adjust the tension of the yarn passing through the setting machine.

17. A yarn setting machine as claimed in Claim 16 wherein the means to adjust the tension is a tension compensator which controls the speed of the drive of the winding head.

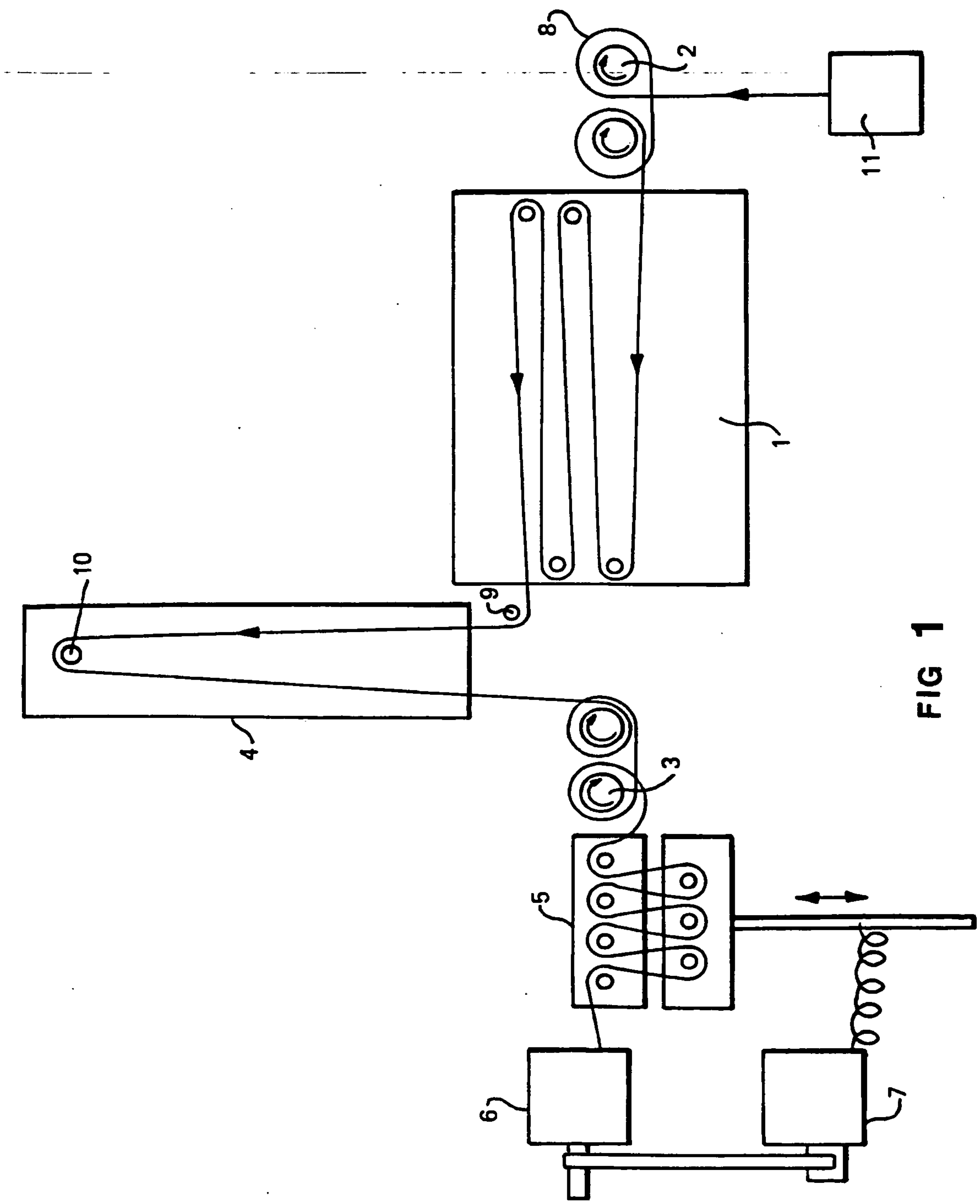

FIG 1

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 D02J1/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 D02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 399 262 (DU PONT) 28 November 1990 see page 3, line 24 - page 5, line 4; example 1	3,4, 13-16
A	US,A,3 553 307 (KOVAC FREDERICK J ET AL) 5 January 1971 see column 2, line 1 - column 3, line 41	1,3,13
P,A	US,A,5 304 414 (BAINBRIDGE ROBERT H ET AL) 19 April 1994 see whole document	1,10,12

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	DATABASE WPI Section Ch, Week 7536 Derwent Publications Ltd., London, GB; Class A23, AN 75-59439W & JP,A,50 014 816 (TEIJIN KK) , 17 February 1975 see abstract -----	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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